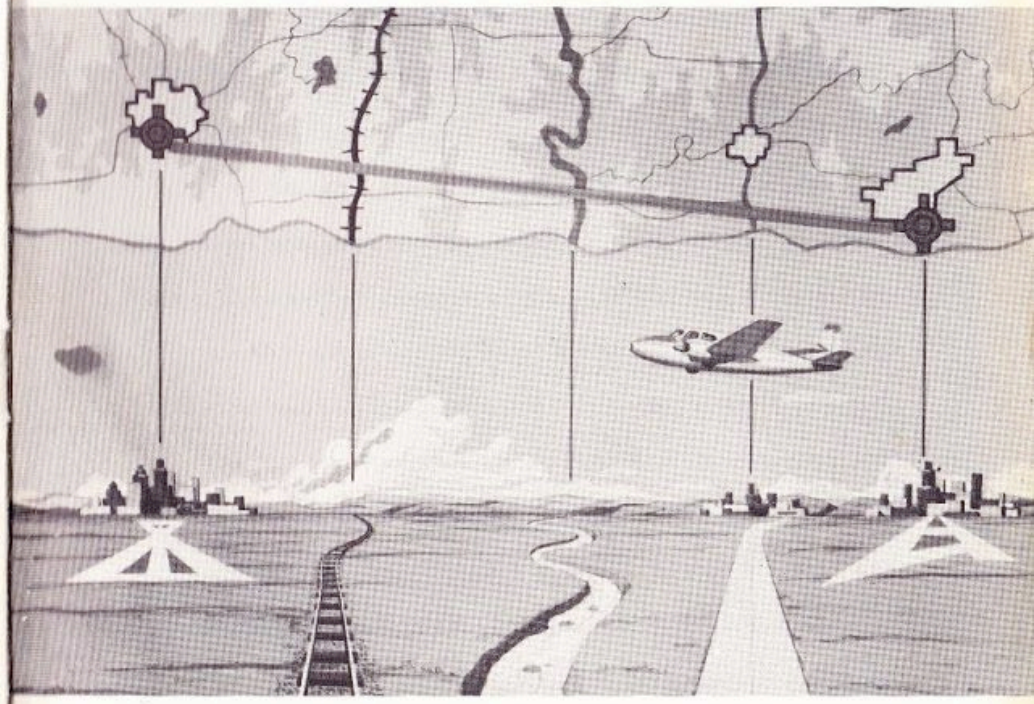
NAVIGATION
AND THE
WEATHER



WORK BOOK

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PREFACE

The exercises and activities prescribed in this workbook will help you attain the purposes of each lesson. These purposes will be brought to your attention by your instructor. No excercise is to be attempted until your reading assignment has been completed. Do not attempt the exercises until you have made preparation after planning with the instructor and paying heed to his presentation at the first lesson session. Do not hesitate to use every method at your command in order to obtain essential information. Observe, read, ask questions of your instructor and the resource people that visit your classroom. You will note that lessons are numbered in accordance with a natural sequence and not with reference to a particular workbook; for example, the first lesson of the workbook: Aircraft in Flight is Lesson VII; that of the workbook: Power for Flight is Lesson XIV. This procedure is also used to identify the lesson plans of the several booklets of the Instructor Guide series.

By means of a key your instructor will help you correct Exercises 1, 2, and 3 of each lesson. Since it has not been possible to key the responses to Exercise 4, the quality of these should be appraised during discussion by students and instructor.

HAROLD E. MEHRENS, Editor

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NAVIGATION AND THE WEATHER

Lesson XXIX

EXERCISE NO. 1

(You have 5 minutes to complete this exercise.)

1. Place a *T* in the blank space preceding a true statement; place an *F* in the blank space preceding a false statement.

a. F A pilot can chart a proper course without regard to the prevailing weather conditions.

b. T A pilot may obtain in-flight weather information from any radio communications station.

c. T Weather forecasts are subject to continuing change.

d. F Pilots do not have to know and understand weather maps and report symbols.

e. T Weather sequence reports are more important to pilots than weather maps and charts.

f. T Aerial navigation is the science of flying from one place to another as directly as circumstances will allow.

g. F The shorter the flight, the more likely that several navigation methods will be employed.

h. T Celestial navigation is more likely to be used on trans-ocean flights.

i. F Aeronautical charts are used only by USAF pilots.

j. T The U. S. Coast and Geodetic Survey prepares and publishes aeronautical charts.

EXERCISE NO. 2

(You have 10 minutes to complete this exercise.)

1. Fill in the blank spaces with the word, or words, that properly complete the statement.

a. Two tasks which require the first attention of a pilot prior to flight are to chart his course and learning the kind of weather he will likely encounter along his route.

b. As it is for ship captains at sea, the compass is an important navigation instrument to aircraft pilots.

c. A statute mile is 5,280 feet, while a nautical mile is 6,080 feet or 1/60 of a degree of the earth's equator.

d. Unless a pilot knows the instant direction and velocity he cannot solve navigation problems involving (1) compass heading, (2) wind drift, (3) ground speed, (4) climb and descent time, and (5) fuel consumption.

e. Radio range signals are interrupted periodically so a pilot in flight can get current weather information.

f. Weather charts are published by the Weather Bureau.

g. Reports of weather encountered by pilots in flight are called pilots and are used by weather forecasters.

h. Lindbergh used two types of navigation on his famous New York to Paris flight. One was pilotage and the other was dead reckoning.

i. Compass Heading may have to be changed from time to time during flight to compensate for wind and keep the aircraft on course.

j. Surface weather maps are prepared four times daily.

EXERCISE NO. 3

(You have 5 minutes to complete this exercise.)

1. Draw a circle around the number preceding the phrase which is best to make the statement a correct expression.

a. Before beginning a flight operation a civilian pilot should get weather information from:

1. Flight Information Service.
2. Meteorological Forecasting Service.
3. The United States Weather Bureau.
4. Newspapers and TV.

b. Sectional aeronautical charts are in a scale of:

1. 16 miles to an inch.
2. 32 miles to an inch.
3. 80 miles to an inch.
4. 8 miles to an inch.

c. The number of stations providing weather information in the United States today is approximately:

1. 1250.
2. 125.
3. 12.
4. 25.

d. To keep an aircraft on course by reference to visible landmarks known to mark the desired flight path is a type of navigation known as:

1. Dead reckoning.
2. Celestial.
3. Visual flight rules (VFR).
4. Pilotage.

e. The type of navigation which requires a pilot to calculate a compass heading before a flight and to keep a record of the direction, distance, and time of flight between positions along the course is called:

1. Dead reckoning.
2. Pilotage.
3. Celestial navigation.
4. Compass navigation.

EXERCISE NO. 4

(You have 15 minutes to complete this exercise.)

List as many signs and symbols shown on an aeronautical chart as possible, and give a location for each type you can identify.

Lesson XXX

EXERCISE NO. 1

(You have 5 minutes to complete this exercise.)

1. Place a *T* in the blank space preceding a true statement; place an *F* in the blank space preceding a false statement.

a. T Imaginary lines perpendicular to the equator and intersecting the poles are called meridians of longitude.

b. F The prime meridian passes through the equator and Greenwich, Connecticut.

c. F Time belts are established for each 15 degrees of latitude.

d. T The great problem in map and chart making is to represent the spherical surface of the earth on a flat map so that direction and distance can be measured accurately.

e. T The most noticeable characteristics of the Mercator map are vertical meridians and horizontal parallels.

f. F A great circle is not the shortest distance between two points.

g. T The Lambert map is used for aeronautical charts.

h. T The bearing (direction) from one place to another is always measured clockwise from north.

i. F The magnetic north pole is the same place as the geographic north pole.

j. T An altimeter's operation is based on the fact that as altitude increases, air pressure decreases.

EXERCISE NO. 2

(You have 10 minutes to complete this exercise.)

1. Fill in the blank spaces with the word, or words, that properly complete the statement.

a. Imaginary lines drawn around the earth parallel to the equator are called parallels of latitude.

b. When it is 1200 hours Eastern Standard Time, it is 0900 hours Pacific Standard Time.

c. Map and chart making is called cartography.

d. When flying due east, you would bear 90 degrees.

e. To determine future course, a line is drawn from departure point to destination, and the angle formed by that line and the meridian midway between those points is measured.

f. On an aeronautical chart, the degree and direction of magnetic variation in an area are shown by isogonic lines.

g. To determine ground speed, a pilot will refer to the clock.

h. Excessive swing of a compass card and needle is dampened by a light oil contained in the compass case.

i. The altimeter lags a few seconds in recording changes in elevation.

j. Elevations above sea level on aeronautical charts are shown by color shades and contour lines.

EXERCISE NO. 3

(You have 5 minutes to complete this exercise.)

1. Draw a circle around the number preceding the phrase which is best to make the statement a correct expression.

a. The angular distance from the Greenwich meridian around the world and back is:

1. 90 degrees.
2. 180 degrees.
3. 270 degrees.
4. (360 degrees.)

b. The Mercator map was devised in the year:

1. 1269.
2. 1912.
3. (1569.)
4. 1857.

c. The reciprocal of a heading of 72 degrees is:

1. 272 degrees.
2. (252 degrees.)
3. 162 degrees.
4. 12 degrees.

d. The following are essential basic instruments for navigation except the:

1. Altimeter.
2. Air speed indicator.
3. Clock.
4. (Ground speed indicator.)

e. A great circle is represented by a continuous straight line on a:

1. Mercator projection.
2. Rhumb line.
3. (Lambert Conformal Conic projection map.)
4. Long distance flight only.

EXERCISE NO. 4

(You have 15 minutes to complete this exercise.)

1. Using an aeronautical chart, locate and write the longitude and latitude of three large cities and the highest and lowest elevation on the chart.

2. Plot a course of at least 200 nautical miles on your chart. Mark your intended track as AB. Now, using a protractor, compute your (1) true course, (2) true heading, (3) magnetic heading, and (4) compass heading. With a no-wind condition and a true air speed of 91 knots, what would your ground speed be?

Lesson XXXI

EXERCISE NO. 1

(You have 5 minutes to complete this exercise.)

1. Place a *T* in the blank space preceding a true statement; place an *F* in the blank space preceding a false statement.

a. F A pilot will always use pilotage if he has a radio-equipped aircraft.

b. F Pre-flight planning is important only because it is required by CAA, Air Force and airline regulations.

c. T The before take-off procedures for pilotage and dead reckoning are the same up to a point.

d. T In pilotage, the first check point should be a prominent landmark near the airport.

e. T The first before take-off step in pilotage is drawing a line on the chart or map from the departure point to the destination.

f. T A good end bracket would be a river running perpendicular to your course and near your destination.

g. T A pilot must compute ground speed in pre-flight planning.

h. F A pilot estimates drift by observing the smoke angle from a nearby smokestack.

i. T A pilot can use pilotage on a night flight.

j. F After a pilot sights his second check point and determines his ground speed, he can put his maps away, because he is sure to remain on course.

EXERCISE NO. 2

(You have 10 minutes to complete this exercise.)

1. Fill in the blank spaces with the word, or words, that properly complete the statement.

a. A Pricket is a terrain feature—such as a railway, river, or prominent highway which parallels a course or a portion of a course.

b. Course is the direction toward the destination, as measured on the chart.

c. Heading is the direction in which the nose of the airplane points during flight.

d. track is the actual path made over the ground in flight. (If proper correction has been made for the wind, Heading and course will be identical.)

e. drift angle is the angle between heading and track.

f. Variation is correction applied to the course in order to establish a heading which will make track coincide with course.

g. air speed is the rate of the plane's progress through the air.

h. ground speed is the rate of the plane's progress over the ground.

i. If an aircraft has no radio equipment, it is restricted to Visual flight rules.

j. A convenient distance of "mark off" segments of the true course line is 10 miles.

EXERCISE NO. 3

(You have 5 minutes to complete this exercise.)

1. Draw a circle around the number preceding the phrase which is best to make the statement a correct expression.

a. As soon as an aircraft leaves the airport and reaches the first check point, it should be turned to the proper:

(1.) Compass course.
2. Magnetic course.
3. Mid-meridian course.
4. True course.

b. To correct for wind drift, point the nose of the aircraft:

1. Away from the wind.
(2.) Into the wind.
3. Up.
4. Down.

c. After noting the elapsed time between your first and second check points you can determine:

1. Air speed.
(2.) Ground speed.
3. Bracket speed.
4. Pilotage speed.

d. If the compass correction card reads for E, steer 88°, and for 120°, steer 118°, your compass heading on magnetic course of 105° would be:

1. 107°.
(3.) 103°.
2. 86°
4. 116°.

e. If you were on a compass heading of 270° and noticed the aircraft drifting to the left of course, your corrected compass heading might be:

1. 272°.
2. 268°.
3. 90°.
4. 270°.

EXERCISE NO. 4

(You have 15 minutes to complete this exercise.)

Using an aeronautical chart, pre-plan a short flight following steps 1-6 on pages 20-21 of *Navigation and the Weather*.

Lesson XXXII

EXERCISE NO. 1

(You have 5 minutes to complete this exercise.)

1. Place a *T* in the blank space preceding a true statement; place an *F* in the blank space preceding a false statement.

a. T In solving a dead reckoning problem, we begin by using the same "before take-off" procedure as in pilotage.

b. T An additional step in solving a dead reckoning problem is that of converting magnetic course to magnetic heading by taking into account the effect of wind speed and direction.

c. F Problems of fuel consumption have no relationship to dead reckoning problems.

d. T If the air speed, true ~~speed~~ course, and wind speed and direction of an airplane are known, we can compute wind correction angle and ground speed.

e. F It is necessary to use a "computer" to solve most dead reckoning problems.

f. T We can solve most types of dead reckoning problems by means of the wind triangle method.

g. F We cannot extend a wind triangle problem graphically in order to compute a round trip.

h. T A vector has both force (or velocity) and direction.

i. T Pilots can solve some types of dead reckoning as a navigational procedure.

EXERCISE NO. 2

(You have 10 minutes to complete this exercise.)

1. Fill in the blank spaces with the word, or words, that properly complete the statement.

a. A Heading is a course corrected for wind effect.

b. In solving a dead reckoning problem prior to take-off, we get our wind speed and direction from one of the weather Service.

c. The wind triangle problem is a Vector problem.

d. We can solve several types of dead reckoning problems by the wind triangle method.

e. Because of magnetic variation, we must compute a magnetic heading (MH). We then determine Compass heading by applying compass deviation.

f. We divide miles per hour into Distance and multiply by rate of fuel consumption to determine required fuel.

g. It takes picture to gain skill and exactness in solving dead reckoning problems.

h. A combination of a scale and a protractor is called a plotter.

i. When you have computed your ground speed, you can estimate your arrival time.

j. There are many dead reckoning problems that can be solved by the Vector diagram.

EXERCISE NO. 3

(You have 5 minutes to complete this exercise.)

1. Draw a circle around the number preceding the phrase which is best to make the statement a correct expression.

a. We can compute CH, GS, time of arrival, and fuel required when, in addition to the compass course and air speed of our aircraft, we also know:

1. The magnetic course.
2. The wind speed and direction.
3. The distance between our points of departure and destination.
4. The true course.

b. The first line to be drawn when solving a dead reckoning problem graphically is the:

1. East-west line.
2. True course line.
3. North-south line.
4. Wind vector.

c. If we have TC of 60°, a wind correction angle of 5°, and wind from the left, we would in determining TH:

1. Add 5° to 60°.
2. Multiply 60° by 5°.
3. Divide 5° into 60°.
4. Subtract 5° from 60°.

d. If our GS is 90 mph, our rate of fuel consumption 5 gallons per hour, and the distance 360 miles, the required fuel for the flight is:

1. 20 gallons.
2. 25 gallons.
3. 72 gallons.
4. 18 gallons.

e. If you had prepared a pilotage flight and decided before take-off to change to a dead reckoning flight, you would take into account wind speed and direction and then convert:

1. Variation to deviation.
2. Compass course to compass deviation.
3. Magnetic course to magnetic heading.
4. True course to compass course.

EXERCISE NO. 4

(You have 15 minutes to complete this exercise.)

1. Using the outline and directions for a dead reckoning problem from pages 25 and 26 of *Navigation and the Weather*, solve the following: TC 75°, AS 80 mph, wind 10 mph from 15°. Find TH and GS.

2. Use the information and answers from problem (1) and make a pilot's planning chart following the examples from page 27 of *Navigation and the Weather*. VAR 1°E, D 3°E. Complete through GS only.

Lesson XXXIII

EXERCISE NO. 1

(You have 5 minutes to complete this exercise.)

1. Place a *T* in the blank space preceding a true statement; place an *F* in the blank space preceding a false statement.

a. T Even though an aircraft is well equipped with electronic navigation aids, successful navigation still depends on the pilot's skill in using them.

b. F If a pilot get off the "beam," he cannot easily get back on.

c. T By flying the "beam," the pilot can fly directly to or from a radio range station.

d. F When a radio compass needle points toward zero, it is receiving strong radio signals.

e. T By means of a radio direction finder with which to find the bearings of at least two stations, a pilot can plot his position.

f. T The celestial coordinates are the parallels of declination and the meridians of the sidereal hour angle.

g. F A solar day is the time it takes a star to leave its sub-stellar point and then return to that point.

h. T Th solar day is longer than the sidereal day because of the movement of the earth in its orbit.

i. T In celestial navigation, we do not use a prime meridian.

j. T The vernal equinox is that point at which the plane of the ecliptic crosses the celestial equator.

EXERCISE NO. 2

(You have 10 minutes to complete this exercise.)

1. Fill in the blank spaces with the word, or words, that properly complete the statement.

a. By controlling the direction of radio waves on a four-course radio range, we can broadcast an a in one direction and a n in the other.

b. When a pilot is on the "beam," flying a radio range, he will hear a steady tone in his earphones.

c. A radio compass is sometimes called a homing device.

d. When using a radio direction finder, a pilot will rotate the loop until he gets a null.

e. An LF/MF radio range will normally have four courses.

f. In celestial navigation, we use the stars as reference points.

g. Each star has at any given time some point on the earth's surface which is directly beneath it. This point is called its sub-stellar point.

h. A navigator must assume that each star has a definite position on the surface of the celestial sphere and that this sphere encloses the terrestrial sphere.

i. The sidereal hour angle is measured only westward from the prime celestial meridian.

j. To measure the altitude of a star, the aerial navigator normally uses an octon.

EXERCISE NO. 3

(You have 5 minutes to complete this exercise.)

1. Draw a circle around the number preceding the phrase which is best to make the statement a correct expression.

a. One type of navigation that is virtually independent of the weather is:

1. Celestial.
2. Pilotage.
3. Dead reckoning.
4. Radio.

b. A publication used to provide data for celestial navigation problems is "HO 249" published by the U. S. Hydrographic Office. Another publication used for the same purpose is:

1. "World Almanac."
2. "Farmers Almanac."
3. "American Air Almanac."
4. "Star Almanac."

c. Two important celestial navigation instruments used by aerial navigators are:

1. Sextant and chronometer.
2. Octant and chronometer.
3. Ecliptic and chronometer.
4. Quadrant and chronometer.

d. Using their substellar point as centers, concentric circles may be drawn to plot a fix from the altitudes of two stars. These circles are called:

1. Circles of parallels.
2. Great circles.
3. Substellar circles.
4. Circles of position.

e. A chronometer is a:

1. A precision instrument used to measure the stars.
2. A celestial navigation aid published by the U. S. Hydrographic Office.
3. Precise and accurate timepiece.
4. Precise and accurate electronic device.

EXERCISE NO. 4

(You have 15 minutes to complete this exercise)

1. Sketch your impression of a four-course radio range, showing the N and A quadrants and the "beam."

2. List all the various kinds of radios and radio aids you can think of that might help a pilot navigate.

3. Write your definition of celestial navigation.

Lesson XXXIV

EXERCISE NO. 1

(You have 5 minutes to complete this exercise.)

1. Place a *T* in the blank space preceding a true statement; place an *F* in the blank space preceding a false statement.

a. T The most simple problems of air navigation illustrate the importance of weather to a pilot, because such problems include wind direction and velocity effects.

b. T The sun is the earth's great source of energy and transfers its heat by means of radiant waves.

c. F All of the sun's radiation toward the earth reaches its destination.

d. T Air density and temperature decreases as altitude above sea level increases.

e. F Insolation at the equator is less, because there the earth's angle of incidence is less.

f. F The wind moves from low to high pressure areas.

g. T Gravity, friction, mountains, and large bodies of water all affect the general circulation of air.

h. T The ratio of the amount of water vapor which a sample of air holds to the amount it can hold when saturated is called relative humidity.

i. F When the air is 100% saturated, precipitation can occur without cloud formations.

j. T Condensation may result when ascending air is affected by the adiabatic process.

EXERCISE NO. 2

(You have 10 minutes to complete this exercise.)

1. Fill in the blank spaces with the word, or words, that properly complete the statement.

a. The atmosphere is estimated to be 600 miles thick.

b. The weight of the upper air compresses the air at sea level and thereby increases its density and volume.

c. The rate at which the earth's surface is heated is called insolation.

d. When water from the earth's surface evaporates, moisture is absorbed.

e. Much of the sun's radiation is absorbed or reflected by the clouds.

f. If the earth did not rotate, air from the equatorial zone would rise rapidly, the upper air would flow toward the poles, and the surface air would move toward the equator.

g. Since the earth rotates, the nature of the air currents is modified by a factor called Coriolis force.

h. Lines of equal pressure on a weather map are called isobars.

i. The term 'dry air' characterizes air that contains no water vapor, while humid air contains water vapor.

j. Jet streams flow at approximate speeds of 100 to 200 mph.

EXERCISE NO. 3

(You have 5 minutes to complete this exercise.)

1. Draw a circle around the number preceding the phrase which is best to make the statement a correct expression.

a. The layer of atmosphere where most of the weather changes take place is called the:

1. Tropopause.
2. Stratosphere.
3. Ionosphere.
4. (Troposphere.)

b. Vertical movements of air are called:

(1.) Convection currents.
2. Concave currents.
3. Under currents.
4. Winds.

c. Jet streams flow at an approximate altitude of:

1. 5,000 feet.
(2.) 30,000 feet.
3. 60,000 feet.
4. 90,000 feet.

d. The process of expansion or compression of a parcel of air when no heat is added, yet a temperature change takes place, is called:

1. Isothermal.
2. Insolation.
(3.) Adiabatic.
4. Coriolis.

e. Jet streams normally flow from:

(1.) West to east.
2. East to west.
3. South to north.
4. North to south.

EXERCISE NO. 4

(You have 15 minutes to complete this exercise.)

1. List and describe the different states of the weather; i.e., rain, etc.

2. State in your own words why you think a pilot should have a thorough knowledge and understanding of the weather.

Lesson XXXV

EXERCISE NO. 1

(You have 5 minutes to complete this exercise.)

1. Place a *T* in the blank space preceding a true statement; place an *F* in the blank space preceding a false statement.

a. T General weather changes are the result of the meeting of air masses having different characteristics.

b. T The movement of a front occurs when one air mass attempts to displace another.

c. F A cold front is characterized by haze, fog, low ceiling, and poor visibility.

d. T A cold front may move from 500 to 700 miles in a day.

e. F An occluded front is formed by vertical waves which cause a high pressure area to form.

f. F The weather man writes descriptions of the weather on his map in longhand.

g. F In this day of modern aviation, thunderstorms are no longer considered as hazards to aircraft in flight.

h. T Turbulence, high winds, heavy rains, lightning, and hail are characteristics of thunderstorms.

i. T The mature stage of a thunderstorm is characterized by updrafts, downdrafts, and severe turbulence.

j. T If pilots are aware of and give consideration to flight hazards before "take-off", their chances of completing a safe flight are increased.

EXERCISE NO. 2

(You have 10 minutes to complete this exercise.)

1. Fill in the blank spaces with the word, or words, that properly complete the statement.

a. The characteristics of an air mass are determined by the source of the air mass.

b. The boundaries between air masses of different characteristics are called fronts.

c. As an occluded front approaches, one first observes warm front characteristics.

d. Cumulus clouds appear to be piled one on top of another, while Stratus clouds are spread out in layers.

e. Wisps of high cirrus clouds observed 400 miles ahead of a front identifies it as an approaching warm front.

f. Hundreds of weather stations each hour transmit reports by teletype.

g. In the dissipating stage of a thunderstorm, the rain decreases and there are down drafts.

h. Thunderstorms are usually mul-i-cell, and each is in a different stage of development at any given time.

i. Before ice can form on an aircraft, there must be visible moisture in the air.

j. low visibility is usually the result of fog, haze, smoke, blowing dust, and the like.

EXERCISE NO. 3

(You have 5 minutes to complete this exercise.)

1. Draw a circle around the number preceding the phrase which is best to make the statement a correct expression.

a. A continental air mass is:

1. Humid.
2. (Dry.)
3. Cold.
4. Hot.

b. A cold front will normally have a squall line ranging in length from:

1. 500-700 miles.
2. 250-500 miles.
3. 150-300 miles.
4. (50-100 miles.)

c. Cumulo-nimbus clouds may be described as appearing piled one on top of another and also:

1. (Raining.)
2. Curly.
3. Very high.
4. Broken.

d. There are three stages in the life of a thunderstorm. One of the following is *not* one of the three stages. It is:

1. Cumulus.
2. (Stratus.)
3. Mature.
4. Dissipating.

e. Icing generally occurs when the temperature is between:

1. (32 °F and 20 °F.)
2. 20 °F and 0 °F.
3. 32 °F and 52 °F.
4. 10 °F and 5 °F.

EXERCISE NO. 4

(You have 15 minutes to complete this exercise.)

1. Write down your estimate of the following weather conditions which now prevail or which existed prior to nightfall:

a. Sky cover — in tenths.
b. Cloud ceiling — in thousands of feet.
c. Visibility — in miles.
d. State of the weather — smoke, fog, etc.
e. Temperature — degrees Fahrenheit.
f. Wind direction — compass direction.
g. Wind velocity — miles per hour.
h. Type precipitation — if any.

2. Use the weather information you listed in 1 above, and from it prepare a station weather report. Refer to diagram at the top of page 57 in your pamphlet.

3. At this point, if you have any questions about the material covered in the previous seven classes, you should bring these to the attention of the instructor. This period should be devoted to discussing all questions which you and other students desire to have answered.

James Coad
May 23, 1960

1. rain small drops of water
snow small partical of dust held together by moisture
fog a low hanging cloud.
dew when the temperture is right for moisture to form.
nail is frozen rain.

2. A pilot should have a thorough knowledge and understanding of the weather so that he may make a safe flight. The pilot should not plan to go through Storms and disterbes of any kind. This is why he has to know about the weather.